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Envisioning Archival Images with Artificial Intelligence

Jessica Bushey

San José State University (USA)
jessica.bushey@sjsu.edu, ORCID 0000-0002-8569-5360

ABSTRACT
The literature review explores the role of Artificial Intelligence (AI) in enhancing access to and management of photographic archives. As digital and analog photographs proliferate in archival institutions, traditional approaches to organizing and describing these materials are increasingly inadequate. The review highlights the potential of AI, particularly computer vision (CV), to address the challenges associated with processing large volumes of digital images. CV algorithms, such as object detection and image classification, can automate tasks like image metadata generation, offering archivists new tools for organizing collections more efficiently. However, the adoption of AI in archival practice raises important ethical concerns, particularly regarding biases inherent in AI training datasets and technologies like facial recognition. Through various case studies, the review demonstrates that interdisciplinary collaboration between archivists, AI specialists, and scholars is crucial to developing effective AI-driven solutions. Projects like CAMPI and the Finnish Wartime Photograph Archive illustrate the practical benefits of AI, while emphasizing the need for archivists to develop AI and visual literacy. This review serves as a foundational resource for archival scholars and practitioners interested in utilizing AI to improve access to photographic archives.

KEYWORDS
archives, photographs, artificial intelligence, computer vision, digital images, AI literacy

Wizja archiwizacji obrazów za pomocą sztucznej inteligencji

STRESZCZENIE
Zawarty w artykule przegląd literatury pokazuje rolę sztucznej inteligencji (AI) w poprawie dostępu do archiwów fotograficznych i zarządzaniu nimi. W instytucjach archiwalnych stale przybywa fotografii cyfrowych i analogowych, przez co tradycyjne metody gromadzenia i opisywania tych materiałów stają się niewystarczające. Przegląd podkreśla potencjał AI, w szczególności rozpoznawania obrazów (widzenia komputerowego, CV), w rozwiązywaniu problemów związanych z przetwarzaniem dużej liczby obrazów cyfrowych. Algorytmy CV, takie jak wykrywanie obiektów i klasyfikacja obrazów, mogą automatyzować generowanie metadanych, oferując archiwistom nowe narzędzia pozwalające na bardziej efektywne zarządzanie gromadzonymi zbiorami. Wdrożenie AI w praktyce archiwalnej budzi jednak istotne obawy natury etycznej, szczególnie w obszarze błędów nierozerwalnie związanych ze zbiorami danych szkoleniowych i technologiami takimi jak rozpoznawanie twarzy. W artykule, poprzez różne studia przypadków, pokazano, że interdyscyplinarna współpraca między archiwistami, specjalistami AI i badaczami ma kluczowe znaczenie dla opracowania skutecznych rozwiązań opartych na sztucznej inteligencji. Projekty typu CAMPI i Finnish Wartime

SŁOWA KLUCZOWE
archiwa, fotografie, sztuczna inteligencja, widzenie komputerowe, obrazy cyfrowe, umiejętność korzystania ze sztucznej inteligencji

Photograph Archive ilustrują praktyczne korzyści płynące ze stosowania AI, jednocześnie podkreślając potrzebę rozwijania przez archiwistów umiejętności z nią związanych. Zebrany przegląd literatury może służyć jako podstawowe źródło dla badaczy i praktyków archiwalnych zainteresowanych wykorzystaniem AI do poprawy dostępu do archiwów fotograficznych.

Introduction[1]

The growing volumes of images in archival institutions reflect our global shift towards communicating with images, a ubiquitous activity spurred by smartphones and social media platforms. Archivists are expected to manage analog photographs, as well as their digitized surrogates and born-digital images. Approaches to arranging and describing visual materials in archives and special collections have been inconsistent, making it challenging for archivists and researchers to discover the provenance of many archival images and understand their function. Too often, contextual information about the who, what, where, when and why of an archival photograph is missing, incomplete, or inaccurate. Current approaches for processing archival materials encourage collection-level descriptions, even if researchers prefer item-level descriptions for photographs and digital images. As a result, finding aids and online catalogues provide high-level access to only a selection of archival images and limited tools to support digital curation and new research methods focused on datasets. Visual records are recognized as highly valuable to researchers yet problematic due to the efforts and tools required to conduct systematic analysis of large quantities with minimal description[2]. "[Up] to this point the use of machine learning has been very scarce in this context. State-of-the-art machine learning algorithms have potential to significantly speed up this task and also provide novel perspectives/ directions […]"[3]. The potential of using AI software, processes and methods to automate image processing and enhance online engagement with digital surrogates and born-digital images is demonstrated in the following literature review. "As the amount of content increases, so do the opportunities for new research and analysis"[4].

1 External funding provided through: AI for Trust in Records and Archives. Partnership Grant (2021–2026). Social Sciences and Humanities Council of Canada.

2 K. Chumachenko, A. Mannisto, A. Iosifidis, J. Raitoharju, *Machine learning based analysis of Finnish world war II photographers*, "IEEE Access" 2020, vol. 8, pp. 144184–144196, https://doi.org/10.1109/ACCESS.2020.3014458 [access: 7.11.2024].

3 Ibidem, p. 144184.

4 C. Oestreicher, *Reference and Access for Archives and Manuscripts*, Chicago 2020, p. 83.

The international research project, I Trust AI (2021–2026)[5] explores the application of Artificial Intelligence (AI) to records management and archival practice. Studies in the Reference and Access working group are focused on identifying approaches that utilize AI tools for increasing access to digital archives, understanding the changes introduced by AI to the archival function of access, and exploring model frameworks for AI pipelines that support reference activities and new digital research methods. This article presents the initial findings of a literature review on AI and archival photographs, conducted as part of a larger I Trust AI study on increasing access to photos, videos and social media records through AI-generated descriptive metadata (RA01). One of the aims of the study is to explore how AI can be used to analyze digitized photographs and add descriptive elements that may be missing. A key driver for this research is the recognition that traditional approaches to describing archival photographs are no longer sustainable or effective in the face of increasing volumes of both digitized and born-digital images. Limited resources and the growing demand for access to archival images place enormous pressure on archivists to do more with less. This is exacerbated further by technology-driven innovations like Google Search and Google Vision, which have significantly transformed public expectations around access to multimedia information. Image recognition technologies, also referred to as computer vision, enable software applications to understand images through a process of image analysis. The public can conduct online searches using images instead of text, and visual image content can be automatically categorized, labeled and queried. With the availability of AI, archivists find themselves experiencing yet another paradigm shift in which stakeholders expect instant, relevant, personalized, and comprehensive access to information and digital records across multiple formats.

The literature review provides a necessary foundation for archivists who are interested in utilizing computer vision algorithms for increasing access and use of photographs, digitized surrogates and eventually, born-digital images, but are unfamiliar with recent developments in this area. It also highlights the importance of visual and AI literacy for archivists working with digital images and providing reference services in the AI era. The following section presents the methodology used for the literature review.

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[5] InterPARES Trust AI is funded by a Social Sciences and Humanities Research Council of Canada (SSHRC) Partnership Grant.

Methods

In early 2023 we launched a literature review on AI software and tools being used in the management of archival photographs and digital images. The scope of the review included research initiatives and scholarly literature in the field of archives, information science, and digital humanities published in the last five years. Research initiatives were sourced from the Institute of Electronics and Electrical Engineers (IEEE) Xplore database. Scholarly literature included the following journals: "Archivaria", "American Archivist", "Archives & Manuscripts", "Archival Science: International Journal on Recorded Information", "ACM Journal on Computing and Cultural Heritage", and the book, *Archives, Access and Artificial Intelligence*[6]. Initially, the goal was to focus specifically on public records in national and municipal archives; however, these parameters were too restrictive, and few resources were identified. Consequently, we expanded the criteria beyond archives to include AI software and tools being used in the management and curation of digital images collections in galleries, libraries and museums, which resulted in 33 selected articles. A further literature review was conducted in 2024 focusing primarily on dissemination by the following research projects: InterPARES Trust AI[7], LUSTRE (Unlocking our Digital Past with Artificial Intelligence, 2022–2024)[8], AEOLIAN Network (Artificial Intelligence for Cultural Organizations, 2021–2023)[9], EyCon (Visual AI and Early Conflict Photography, 2020–2023)[10], and AURA Network (Archives in the UK/Republic of Ireland & AI, 2020–2021)[11], which provided an additional 8 articles and a blog post related to our keywords.

The following keywords were used: digital archives, photoarchive, public records, digital humanities, cultural heritage, image management, image

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6 *Archives, Access and Artificial Intelligence: Working with Born-Digital and Digitized Archival Collections*, ed. L. Jaillant, Bielefeld 2022.

7 InterPARES Trust AI (2021–2026). Primary Investigator, Luciana Duranti. See: https://interparestrustai.org/ [access: 7.11.2024].

8 LUSTRE (2022–2024). Primary Investigator, Lise Jaillant. See: https://lustre-network.net/team/ [access: 7.11.2024].

9 AEOLIAN Network (2021–2023). Primary Investigator, Lise Jaillant. See: https://www.aeolian-network.net/ [access: 7.11.2024].

10 EyCon (2022–2024). Primary Investigator, Lise Jaillant. See: https://eycon.hypotheses.org/ [access: 7.11.2024].

11 AURA Network (2020–2022). Primary Investigator, Lise Jaillant. See: https://www.aura-network.net/ [access: 7.11.2024].

retrieval, image analysis, photography, image metadata, computer vision (CV), artificial intelligence (AI), deep learning (DL), machine learning (ML), and object detection (OD).

The author and graduate researchers contributed to a literature review matrix that captured: source, source type, summary, key points, keywords, and limitations. Bimonthly meetings and Google Docs facilitated communication amongst the research team and provided an opportunity to iteratively evaluate sources. Twenty-nine sources were selected for further analysis. The research team broadly grouped sources according to how AI was being applied: image management and description, or online access and use. The theme that emerged is the predominance of computer vision (CV), a branch of AI focused on enabling machines to interpret and understand visual data in ways that resemble human vision. The literature review focuses on initiatives and articles that discuss the application of CV to aggregates of digitized images for back-end activities of archival description and front-end activities of digital curation. Within these sources, several themes emerged: collaboration and interdisciplinary skills, ethical considerations; and visual and AI literacy for archivists. The following section presents the results of the literature review along with a discussion of the themes identified by the research team.

Results & Discussion

There is a growing body of literature on the application of AI to records management and archival functions[12], responsible AI in libraries and archives[13], and digital humanities scholars using AI to access digitized collections and born-digital archives[14]. Within this literature, there is an emerging subset of articles that explore new approaches to describing and accessing archival photographs and digital images. Central to these approaches is the recognition that unlike texts, digital images differ in their representation and interpretation. In the

[12] G. Colavizza, T. Blanke, C. Jeurgens, J. Noordegraaf, *Archives and AI: An overview of current debates and future perspectives,* "Journal on Computing and Cultural Heritage" 2021, vol. 15, no. 1, article 4, pp. 1–15, https://doi.org/10.1145/3479010 [access: 7.11.2024].

[13] S. Mannheimer et al., *Introduction to the Special Issue: Responsible AI in Libraries and Archives*, "Journal of eScience Librarianship" 2024, vol. 13, no. 1, https://publishing.escholarship.umassmed.edu/jeslib/article/id/860/ [access: 7.11.2024].

[14] *Archives, Access and Artificial Intelligence*…

archival discipline a foundation of scholarship on the value of photographs and digital images as archival records exists, one which emphasizes the necessity of archival description to communicate the context of visual records and facilitate access and use[15]. The application of AI to photoarchives presents an opportunity for archivists to explore new approaches and tools that provide solutions to existing challenges and raise new questions about representing and interpreting the content and context of archival images on a large scale.

AI and Image Management & Description

The literature review highlights the role of computer vision (CV) to enable machines to "see" and interpret digital images in ways that resemble human approaches to extracting meaningful information from images, but on a much larger scale and in a fraction of the time. In order to teach machines how to extract meaningful information from images, archivists need to digitize analog

[15] W.H. Leary, *The archival appraisal of photographs: a RAMP study with guidelines*, Paris 1985, https://unesdoc.unesco.org/ark:/48223/pf0000063749 [access: 7.11.2024]; L. O'Donnell, *Towards Total Archives: The Form and Meaning of Photographic Records*, "Archivaria" 1994, vol. 38, pp. 105–118, https://archivaria.ca/index.php/archivaria/article/view/12028 [access: 7.11.2024]; J.M. Schwartz, *"We Make Our Tools and Our Tools Make Us": Lessons from Photographs for the Practice, Politics, and Poetics of Diplomatics*, ibidem, 1995, vol. 40, pp. 40–74, https://archivaria.ca/index.php/archivaria/article/view/12096 [access: 7.11.2024]; idem, *Records of Simple Truth and Precision: Photography, Archives, and the Illusion of Control*, ibidem, 2000, vol. 50, pp. 1–40, https://archivaria.ca/index.php/archivaria/article/view/12763 [access: 7.11.2024]; idem, *Coming to Terms with Photographs: Descriptive Standards, Linguistic "Othering" and the Margins of Archivy*, ibidem, 2002, vol. 54, pp. 142–171, https://archivaria.ca/index.php/archivaria/article/view/12861 [access: 7.11.2024]; J. Bushey, *Born digital images as reliable and authentic records*, master's thesis: University of British Columbia, 2005, https://doi.org/10.14288/1.0092057 [access: 7.11.2024]; M.L. Ritzenthaler, D. Vogt-O'Connor, *Photographs: archival care and management*, Chicago 2006, https://search.worldcat.org/title/Photographs-:-archival-care-and-management/oclc/70175019 [access: 7.11.2024]; J. Delaney, *An Inconvenient Truth? Scientific Photography and Archival Ambivalence*, "Archivaria" 2008, vol. 65, pp. 75–95, https://archivaria.ca/index.php/archivaria/article/view/13169 [access: 7.11.2024]; J. Bushey, *He Shoots, He Stores: New Photographic Practice in the Digital Age*, ibidem, 2008, vol. 65, issue 1, pp. 125–149, https://archivaria.ca/index.php/archivaria/article/view/13172 [access: 7.11.2024]; P. Conway, R.L. Punzalan, *Fields of Vision: Toward a New Theory of Visual Literacy for Digitized Archival Photographs*, ibidem, 2011, vol. 71, pp. 63–97, https://archivaria.ca/index.php/archivaria/article/view/13331 [access: 7.11.2024]; J. Bushey, *The archival trustworthiness of digital photographs in social media platforms*, doctoral thesis: University of British Columbia, 2016, https://doi.org/10.14288/1.0300440 [access: 7.11.2024].

photographs so that the image data is suitable for analysis. CV algorithms can perform specific tasks such as object detection, facial recognition and visual search. The 2020 article *The Visual Digital Turn* by Melvin Wevers and Thomas Smits discusses how neural networks and other computer vision techniques can revolutionize the analysis of visual materials, in this case- historical Dutch newspapers from the 17th to 20th century that were digitized by the Dutch Royal Library[16]. The article demonstrates the relationship between convolutional neural networks (CNNs) and CV, informing archivists how CNNs are the primary tool used to perform many of the tasks within the field of CV. In doing so, this article is a good starting point for archivists interested in understanding the role of CNNs in CV tasks such as object detection, image classification, and facial recognition. CNNs can learn hierarchical features from image pixel data. "They can be used to explore the content (what is represented) and the style (how is it represented) of images"[17]. In this project, CV feature detection was used to automate the classification of different media types, such as text, illustrations and photographs. Visual similarity was used to cluster media and allow for longitudinal analysis of media trends over time. Lastly, historians and domain experts created categories that were used to refine the CV algorithms to recognize culturally significant elements and images. Ideally, classification "should be done using the input of domain experts, and perhaps related to the research question at hand"[18] to provide context. The limitations of the study are that ML models were trained on a limited set of labeled images, impacting the generalizability of the categories beyond the specific dataset of Dutch newspapers. The authors highlight the value of CV as a new technique to query visual content of digital archives, without having to rely on textual elements"[19]. This study illustrates the potential for CV tasks to cluster and classify images as part of image processing workflows and highlights the importance of domain expertise when training tools for object detection and classification of archival materials.

In *Machine Learning Based Analysis of Finnish World War II Photographers*, the authors demonstrate how CV object detection can be used to automate the

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16 M. Wevers, T. Smits, *The visual digital turn: Using neural networks to study historical images*, "Digital Scholarship in the Humanities" 2020, vol. 35, issue 1, pp. 194–207, https://doi.org/10.1093/llc/fqy085 [access: 7.11.2024].

17 Ibidem, p. 195.

18 Ibidem, p. 201.

19 Ibidem, p. 204.

analysis of a large corpus of archival image[20]. The Finnish Wartime Photograph Archive is comprised of 160,000 photographs taken by men serving with the TiedotusKomppania (Information Company) troops during World War II. The archival photographs were digitized in 2010 and made available to the public in 2013 and are used extensively by researchers in fields of history, geography, journalism and propaganda. Although many photographs include information about who (name of photographer), what (brief content description), where (place), and when (date), there are thousands of photographs with incomplete information or none whatsoever. This presents challenges for identification, access and use. The authors selected 23 Finnish war photographers from the archive and used ML and CV to detect objects present in the content of the photographs, evaluate photo framing styles, provide photographer classification, and asses the visual similarity of different photographs and photographers. Simply put, using single-shot detectors to analyze the content of digitized images of the analog photographs, researchers were able to train a neural network to successfully recognize 23 photographers by analyzing the image's content and framing within the image.

The aim of the project is twofold, to demonstrate how four object detection methods can be used in a pipeline for analysis of historical photographs, and to provide the codes, models and data annotations with descriptions of how to use them on Github[21]. At this early stage in adoption of CV for analyzing large aggregates of archival images, there is an emphasis throughout the literature on explaining processes and listing tools employed in different CV tasks. The authors draw on general algorithms and publicly available training data with the intent that their approach and methods can be applied to any archival dataset by researchers or cultural heritage professionals without backgrounds in information technology. Kateryna Chumachenko *et al.* demonstrate how four different object detection methods can be used to evaluate images and provide archivists with a methodology for processing large-scale collections of digital images with minimal metadata[22]. Through a process of image content analysis, the CV pipeline includes single-stage detectors SSD, You Only Look Once (YOLOv3) and RetinaNet, each using a single deep neural network to detect

20 K. Chumachenko, A. Mannisto, A. Iosifidis, J. Raitoharju, *Machine learning based analysis*...

21 See: Github. katerynaCh / Finnish-WW2-photographers-analysis, https://github.com/katerynaCh/Finnish-WW2-photographers-analysis [access: 7.11.2024].

22 K. Chumachenko, A. Mannisto, A. Iosifidis, J. Raitoharju, *Machine learning based analysis*...

objects in images and are pretrained on ImageNET dataset. The object detection locates objects with bounding boxes within the image frame. The double-short detector, Mask Region-based Convolutional Neural Networks (R-CNN) enables several regions to be selected from an image and labeled into categories. The labels are created based on predefined classes (or classification schema) given to the AI program. The relevance of this project is its novel use of CV to recognize individual photographers based on visual patterns unique to their images. As suggested by the authors, this process can support reconciling images by the same photographer and facilitate metadata addition for images with little to no information.

Another project utilizing the CV task of image similarity analysis is the Computer-Aided Metadata generation for Photo Archives Initiative (CAMPI) at Carnegie Mellon University Libraries[23]. The aim of the project is to use image similarity to assist librarians in processing digital images collections through the creation of a web app. An interdisciplinary team at Carnegie focused on the 21,000 digitized images in the Carnegie Mellon University Archives' General Photograph Collection, which had little to no metadata linked to the images. The web app CAMPI enabled archivists to tag a photo and then retrieve other images with similar content structure and forms, such as rooms, angles of students facing lecturers, etc. The search retrieves images with visual similarity from within the digitized corpus of the archives. Starting with a "seed image" the app can retrieve similar images that may span across years and throughout collections, enabling the archivist to discover potentially related images that are missing descriptive information. CAMPI also allowed archivists to retrieve a set of similar images and select the best representation in response to a reference request. The authors discuss the use of CV tools that are pre-trained using large visual databases such as ImageNet. In the CAMPI project, image features were generated using the pre-trained model InceptionV3. It took 1.5 hours to compute all the features for 21, 000 images. CAMPI demonstrates how CV techniques, particularly visual similarity search, can be effectively applied to assist archivists in processing and organizing large photograph collections that have been digitized.

Throughout the literature, decisions regarding the use of pre-trained models with CV tasks are based on several factors, including the size of existing archives,

[23] M. Lincoln, J. Corrin, E. Davis, S.B. Weingart, *CAMPI: computer-aided metadata generation for photo archives initiative*, Pittsburgh 2020, https://doi.org/10.1184/R1/12791807.v2 [access: 7.11.2024].

the subjects and activities represented in the image content, the resources available to train the model, and the potential risk of introducing bias. Human validation and the inclusion of subject area experts is encouraged, and, in some cases, models may need to be trained from scratch. Paying attention to training data origins is encouraged in order to understand the introduction of bias in projects employing ML. Several studies included in the literature review highlight the challenges of using CV tools that have been trained using large datasets, such as ImageNet (e.g., CAMPI), unknown sources[24], or limited sources[25]. ImageNet is the largest image database for computer vision tasks and contains millions of images gathered online, primarily from the image platform Flickr and classified into thousands of categories. Archivists need to be aware that the source of the images, their labeling and organization introduces bias that will impact the representation and interpretation of archival materials. It is argued in the literature that bias has always been present in the interpretation and representation of archival photographs[26].

One specialized form of object detection that is contentious within the literature due to its applications in law enforcement is facial recognition. As a CV task it focuses on detection (e.g., locating faces within an image), extraction (e.g., analyzing facial features and characteristics) and identification (e.g., matching detected faces to known identities) of human faces. Both object detection and facial recognition use CNNs. Rebecca Bakker *et al.* presents a study at Florida International University (FIU) that applies facial recognition to digitized images of local public figures and city and municipal officials[27]. The authors discuss the importance of metadata to support access and use; "[h]owever, correctly identifying images of individuals within photographic archives is particularly intensive and ultimately costly when it comes to the amount of time spent on processing a photographic collection; especially ones that have missing

[24] R. Bakker et al., *AI for archives: Using facial recognition to enhance metadata*, "Works of the FIU Libraries" 2020, vol. 93, pp. 1–15, https://digitalcommons.fiu.edu/glworks/93 [access: 7.11.2024].

[25] J. Proctor, R. Marciano, *An AI-assisted framework for rapid conversion of descriptive photo metadata into linked data* [in:] *IEEE International Conference on Big Data (Big Data)*, 2021, pp. 2255–2261, https://doi.org/10.1109/BigData52589.2021.9671715 [access: 7.11.2024].

[26] F. Eiler, S. Graf, W. Dorner, *Artificial intelligence and the automatic classification of historical photographs* [in:] *Proceedings of the Sixth International Conference on Technological Ecosystems for Enhancing Multiculturality*, ed. F.J. García-Peñalvo, New York 2018, pp. 852–856, https://doi.org/10.1145/3284179.3284324 [access: 7.11.2024].

[27] R. Bakker et al., *AI for archives*…

identifying metadata"[28]. The authors reviewed facial recognition applications OpenCV, Face++, and Amazon AWS to determine the most effective approach and tools for producing metadata for digital images collections. The strengths of this article are its documentation of two approaches, an in-house trained model and a cloud-based AI platform, the identification and analysis of different commercially available CV tools, and the discussion of the ethical implications and privacy concerns surrounding the use of AI in archives. "Despite the narrow scope of this research project, we found that ethical concerns of using AI, Machine Learning and Facial Recognition in the archived photographs had to be considered at almost every stage of our project"[29].

In their findings, Bakker *et al*. report that Amazon AWS was the most effective, with 96.9% confidence percentage, yet it was the slowest of the applications. They found that while in-house trained models were faster, larger datasets were needed to produce the same quality of results that cloud-based datasets offer[30]. The easy-to-start environment provided by cloud-based platforms, such as Amazon AWS could appeal to cultural institutions with medium-sized collections. Ultimately, this study highlights the importance of determining in-house expertise, the volume of images to be processed, project timeline, funding limitations, and ethical concerns prior to selecting ML and CV tools. Bakker *et al*. noted a marked decrease in time spent describing photographs, which supports the use of facial recognition software for reducing not only the effort, but the cost of adding metadata about the identity of persons represented in digitized and born-digital images archives. The authors suggest that as new acquisitions are processed, facial recognition tools trained on the FIU image archive can be applied, reducing processing times and increasing metadata application. The authors note that previous methods to identify people in the FIU collections relied on tacit knowledge of long-term staff, which presents a challenge when those archivists retire and/or leave the organization.

The literature reveals the prevalence and necessity of interdisciplinary teams from the fields of cultural heritage preservation and computer science that combine CV tasks, including facial recognition in pipelines aimed at metadata

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28 Ibidem, p. 2.

29 Ibidem, p. 6.

30 R. Bakker et al., *AI for archives…*, p. 13.

annotation and image retrieval[31]. A collaborative project between Flemish cultural organizations and Ghent University presents a valuable case study that uses an open-source tool to semi-automate metadata creation and enrichment using facial recognition of images and videos[32]. The FAME project (facial recognition through metadata creation) is aimed at providing an affordable and accessible AI tool for cultural heritage organizations to use on their own. The Han *et al.* case study of the Frick Art Reference Library's Photoarchive is an application of CV to digitized images of works of art[33]. This article is important for its collaborative methodology between CV experts and the art historian community, resulting in "a pipeline that possesses mutually acknowledged practicality"[34]. The findings reveal that pre-training models using the Photoarchive's classification system and human validation, results in better performance and higher accuracy. This case study demonstrates that deep neural networks can be adapted to classify images via "specialized, hierarchical, multilabel classification systems"[35]. Jennifer Proctor and Richard Marciano's study at Spelman College photo archives tested a computational processing workflow that integrated textual and photographic resources to produce contextual metadata[36]. This multimodal approach highlights the use of linked data to integrate other voices and authorities into a collection. The framework they used was designed to work with existing item-level metadata standards, and their process started off with conducting a statistical analysis of the whole photo collection using OpenRefine. Their study found that their framework's performance shows promising results for the future of automated linking. This article informs cultural heritage professionals on how to integrate deeper text-based contextual information into photo archives, which can support complex queries and more expansive uses.

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31 K. Milleville et al., *Enriching image archives via facial recognition,* "Journal on Computing and Cultural Heritage" 2023, vol. 16, no. 4, pp. 1–18, https://doi.org/10.1145/3606704 [access: 7.11.2024]; X.Y. Han et al.*, Chapter 1: Artificial intelligence and discovering the digitized photoarchive* [in:] *Digital Humanities Research*, ed. L. Jailant, Bielefeld 2022, pp. 29–60, https://doi.org/10.14361/9783839455845-002 [access: 7.11.2024]; J. Proctor, R. Marciano, *An AI-assisted framework…*

32 K. Milleville et al., *Enriching image archives…*

33 X.Y. Han et al.*, Chapter 1: Artificial intelligence…*

34 Ibidem, p. 30.

35 Ibidem, p. 57.

36 J. Proctor, R. Marciano, *An AI-assisted framework…*

AI and Image Access & Use

The literature review reveals several studies that focus on building platforms that utilize ML and CV to support enhanced access and use of archival images[37]. The Deep Discoveries project, part of the Towards a National Collection initiative in the UK explores how CV and explainable AI (XAI) can be used to enhance access to and across visual collections in LAMs[38]. Goals of the project include developing a CV-search platform that enables visual records to be linked across institutions based on visual properties (e.g., pattern, style, colour etc.) and engaging with users of digital images collections to identify barriers to user access and discovery. An interdisciplinary team of cultural heritage professionals, software developers and engineers, UX researchers and CV scientists worked together over 18-months. Lora Angelova *et al*. highlight the "tension in presenting online visual collections between giving the user an understanding of the full scale of a collection (this can be overwhelming, and also misleading as most organizations have digitized only a small fraction of their entire content), and supporting exploration through guided recommendations, which can trap users in a filter bubble"[39]. Their research supports the creation of a search platform for general audiences and specialist researchers. Users can visually articulate their search task, which means that users can query the database with an image instead of text. The platform also enables users to visualize how the AI determined the similarity between their query image and the returned images[40]. The study findings provide detailed information about the back-end CV algorithms used, including three visual style models and three semantic models trained on the ImageNet dataset, as well as the GradCam

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37 L. Angelova et al., *Deep discoveries: A towards a national collection foundation project final report*, 2021, https://doi.org/10.5281/zenodo.5710412 [access: 7.11.2024]; S. Mallick, *EyCon: What are we doing with Machine Learning and Computer Vision*, EYCON Blog Post, 2022, https://eycon.hypotheses.org/1020 [access: 7.11.2024]; K. Aske, M. Giardinetti, *(Mis)matching Metadata: Improving Accessibility in Digital Visual Archives through the EyCon Project*, "Journal on Computing and Cultural Heritage" 2023, vol. 16, issue 4, article 76, pp. 1–20, https://doi.org/10.1145/3594726 [access: 7.11.2024]; T. Arnold, N. Ayers, J. Madron, R. Nelson, L. Tilton, *Visualizing a Large Spatiotemporal Collection of Historic Photography with a Generous Interface. Presented at the 5th Workshop on Visualization for the Digital Humanities*, 2020, https://doi.org/10.48550/arXiv.2009.02242 [access: 7.11.2024]; T. Arnold, L. Tilton, *Distant Viewing: Computational Exploration of Digital Images*, Cambridge 2023.

38 L. Angelova et al., *Deep discoveries*…

39 Ibidem, p. 10.

40 Ibidem, p. 1.

method to provide explanations of the visual search results to the user. Feedback on the CV-based and XAI platform for visual image collections revealed that users with prior experience with CV searches through Google and Amazon "had more trust in the images and metadata returned in an institutionally-driven search platform"[41]. There are important takeaways from this project, in particular the insight into trust relationships between archival institutions and online users. As the adoption of AI tools into archival functions of description and access proceed, archivists must ensure that transparency and accountability continue to be built into systems.

A significant interdisciplinary effort, the Early Conflict (EyCon) Photography Project utilizes CV techniques to analyze and improve access to early conflict photography from 1890–1918. The project aims to increase the discoverability, usability, and accessibility of overlooked and scattered archival materials related to armed conflicts, roughly 130,000 images and pages. Soumik Mallick discusses how the EyCon Project employs a combination of ML[42], DL and CV tasks to analyze and extract images from albums and newspapers (e.g., Layout Parser) and analyze digitized image content to detect and locate objects of interest, such as humans and horses (e.g., YOLOv3 pre-trained on the Cifer 100 dataset). Their methodology for using pre-trained object detection is to first create specific classes that correspond to objects being detected. They then annotate part of the collection with all elements needed as well as identify location to automate recognition. Training is then semi-supervised to allow AI to learn from algorithms. As Mallick states: "DL and CV have opened innovative opportunities for computer science researchers to assist the wider research community with automatic tools, and further understand document layout and objects. They can recognize meaningful patterns in historical data that are intrinsically related to human perception, and can assist experts in document layout analysis, such as object detection in war photography"[43]. These activities support the goals of the Eycon project, which are to aggregate photographic material from separate repositories into a thematic collection focusing on non-European wars; and developing AI techniques that aid in metadata enrichment for large collections of photographs.

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41 Ibidem, p. 13.

42 S. Mallick, *EyCon: What are we doing…*

43 Ibidem, p. 1.

Katherina Aske and Marina Giardinetti discuss the challenge of different institutional approaches to metadata from the perspective of researchers trying to cross-examine photographs in potentially related collections at different institutions[44]. Jonathan Dentler explores the application of a multi-modal approach to historical research that would utilize a visual similarity tool to quickly find instances of the same image in different publications, different formats, and in different archives, then utilize a text processor to analyze and compare attributions such as the photographer, location and/or date to support an action of suggesting attributions for the images[45]. This approach utilizes visual similarity algorithms and textual similarity algorithms. The latter incorporates probabilistic predictions for word order to produce results. From a user perspective, the EyCon application would provide the option to search solely on the basis of visual similarity, solely on the basis of text, or with a combined approach. A user could query the database using an image, enter a text query, or provide both an image file and additional text associated with the image. EyCon is promoting the use of the International Image Interoperability Framework (IIIF) standard to provide continuity and predictability in image search platforms. Additionally, the suggestions provided to researchers are AI-generated, therefore it will be important to highlight this for purposes of transparency and accountability.

Over a decade ago, the Photogrammar web platform was launched as an open-access digital humanities site for search and discovery of a photographic archive through a map and search function. The name of the site draws on photography theory and data visualization to offer researchers "new ways to read, see, and view photography"[46]. In its current state (Version 3.0), Photogrammar is a web-based visualization platform for the 170,000 images taken by the Farm Security Administration and Office of War Information agencies of the U.S. Federal Government 1935–1943. The evolution of the site's interface and computer vision technologies place access and user engagement as drivers for change[47]. Recent

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44 K. Aske, M. Giardinetti, *(Mis)matching Metadata…*

45 J. Dentler, *Workshop Report: Multimodal Visual Similarity Algorithms and Digitized Photo Archives. EyCon Visual AI and Early Conflict Photography*, Blog Post, 2023, https://eycon.hypotheses.org/1539 [access: 7.11.2024].

46 T. Arnold et al., *Photogrammar (Version 3.0)*, 2021, https://photogrammar.org/about [access: 7.11.2024].

47 T. Arnold, P. Leonard, L. Tilton, *Knowledge Creation Through Recommender Systems,* "Digital Scholarship in the Humanities" 2017, vol. 32, pp. 151–157, https://doi.org/10.1093/llc/fqx035 [access: 7.11.2024]; J. Cox, L. Tilton, *The digital Public Humanities: Giving New Arguments and*

developments to enhance context and provide users with access to supporting audiovisual archives, such as oral history interviews and digitized film strips is a result of a partnership with the Smithsonian Archives of American Art (AAA). In some ways, this demonstrates the reciprocal relationship between algorithmic approaches and provenance-based archival practices.

Visual and AI Literacy

Learning about the application of AI to archival photographs and digital images introduces archivists to new theoretical and methodological approaches to analyzing large visual corpora. As noted in the introduction, archivists and archival scholars working with photographs and digital images assert the importance of critically analyzing not only image content, but context to understand the meaning of images. Being visually literate enables archivists to recognize the relationships between images within a fonds, across institutional holdings and within larger historical, socio-cultural and technological contexts. AI literacy refers to an understanding of how AI technologies, including ML and CV, can be used to process and analyze images. Of the many I Trust AI studies, there are two studies that are aimed at furthering the education of records managers and archivists regarding AI literacy and computational skills. The study on AI Literacy for Records Management and Archives, led by Moises Rockembach investigates the nuances of AI literacy among records management and archival professionals, categorizing proficiency levels from beginners to experts. As discussed in the literature review, collaboration and partnerships with interdisciplinary teams is currently necessary to combine traditional archival knowledge with new AI technologies to lead to innovative approaches to managing and accessing archives, in particular digital image archives. Rockembach builds on the work of Duri Long and Brian Magerko[48], asserting that "AI literacy and developing competencies

New Ways to Argue, „Review of Communication" 2019, vol. 19, issue 2, pp. 127–146, https://doi.org/10.1080/15358593.2019.1598569 [access: 7.11.2024]; T. Arnold et al., *Visualizing a Large Spatiotemporal Collection*…

48 M. Rockembach, *AI Literacy: A Muse for Records Management and Archival Professionals* [in:] *Artificial Intelligence and Documentary Heritage. SCEaR Newsletter 2024, Special Issue 2024*, eds. L. Duranti, C. Rogers, 2024, pp. 90–95, https://interparestrustai.org/assets/public/dissemination/SCEaRNewsletterSpecialIssue2024ArtificialIntelligence.pdf [access: 7.11.2024]; D. Long, B. Magerko, *What is AI literacy? Competencies and design considerations* [in:]

in understanding and applying AI technologies is essential for interdisciplinary collaboration and innovation"[49]. Based on ongoing research, Rockembach presents an AI literacy framework of six categories aimed at collectively providing records managers and archival professionals with a comprehensive understanding and skillset "to navigate and leverage AI technologies effectively"[50].

Taylor Arnold and Lauren Tilton's recent publication *Distant Viewing: Computational exploration of Digital Images* provides a deep dive into the epistemological and methodological foundation of distant viewing[51], which they define as "the application of computer vision methods to the computational analysis of digital images"[52]. As archivists working with archival images turn their attention to improving access and use through the application of ML and CV to online platforms and image management, a critical understanding of the possibilities and limitations of these evolving technologies offered by Arnold and Tilton is a valuable perspective.

Another I Trust AI study, Teachable AI for Arrangement and Description, led by Richard Arias Hernandez focuses on creating educational materials to train archival professionals and students to leverage AI in their archival work. This ongoing research has produced nine educational case studies, two of which address the topics of AI for photographs[53]. As discussed in the literature review, gaining an understanding of recent applications of AI to photo archives can assist archival professionals in learning about AI technologies and approaches to improving image management and access. The educational materials provide digestible case studies that highlight their educational applications (e.g., the value of computer vision in archives) and educational topics (e.g., types of AI/ML for photographs), as well as potential discussion questions (e.g., In what ways does bias in facial recognition impact accurate representation?).

CHI'20: proceedings of the 2020 CHI Conference on Human Factors in Computing Systems: April 25–30, 2020, Honolulu, HI, USA, New York 2020, pp. 1–16.

49 M. Rockembach, *AI Literacy…*, p. 91.

50 Ibidem, p. 92.

51 T. Arnold, L. Tilton, *Distant Viewing…*

52 Ibidem, p. 3

53 K. Fewster, *Case Study: The Endangered Archives Programme's use of AI tools in evaluating Jacques Toussele's Cameroonian photography archives*, InterPARES Trust AI, 2024, https://interparestrustai.org/assets/public/dissemination/ZeitlynInterviewCaseStudy.pdf [access: 7.11.2024]; eadem, *Case Study: Testing computational Archival Science frameworks using AI tools in analyzing the Spelman College Archives photograph collection*, InterPARES Trust AI, 2024, https://interparestrustai.org/assets/public/dissemination/ProctorCaseStudy.pdf [access: 7.11.2024].

Conclusion

In reviewing the literature on the application of AI to archival images it became necessary to do additional research and reading into the technological processes of ML and CV. As this study is being conducted under the auspices of the I Trust AI project, the researchers had access to computer scientists and AI experts; yet it still required considerable effort to understand what a model CV framework looks like and how it functions depending on choices of pretrained datasets or not, supervised learning or not, etc. As we reviewed the literature, we quickly identified the common thread of interdisciplinary teams comprised of computer scientists, computer vision experts, cultural heritage and information professionals, and digital humanities scholars. The rapid pace of technological development in the area of ML and CV and the complexity of these projects require collaboration and partnerships. The literature review reveals that the majority of articles are written by interdisciplinary teams of researchers who are working at different institutions and organizations. It is also important to recognize that at this stage, the discussion stems from projects and case studies that were initiated with grants provided by international and national funding agencies, such as SSHRC, NEH and NCF. A shared goal throughout much of the literature is to turn projects into programs and prototypes into platforms. Many of the articles purposefully list the CV tools employed, and the image datasets used for training, along with links to Github repositories with the aim of building a foundation from which other archivists and information professionals can stand upon. The question of how feasible these tools are for everyday image management and access within GLAM organizations is not addressed in the literature.

By focusing on how AI is being applied to increase access and enhance the use of archival photographs and digital images, the literature shows that ML and CV processes and methods are actively being explored by GLAMs and implemented, as in the cases of The Finnish Archive and Photogrammar web platform. In some cases, the research products include webinars, and workshops, along with books and articles. This demonstrates an awareness that archivists need training and support to critically engage with the AI era and engage with new technologies responsibly. It is necessary for archivists to understand the ethical implications of using CV tasks, such as facial recognition that utilizes training data that may introduce biases. At a time when archives are actively dismantling the legacy of colonial frameworks and practices, it would be a tragic misstep to incorporate AI

tools without considerable forethought and understanding of the impact on the representation and interpretation of archival records.

Bibliography

Angelova L., Ogden B., Craig J., Chandrapal H., Manandhar D., *Deep discoveries: A towards a national collection foundation project final report*, 2021, https://doi.org/10.5281/zenodo.5710412 [access: 7.11.2024].

Archives, Access and Artificial Intelligence: Working with Born-Digital and Digitized Archival Collections, ed. L. Jaillant, Bielefeld 2022.

Arnold T., Ayers N., Madron J., Nelson R, Tilton L., *Visualizing a Large Spatiotemporal Collection of Historic Photography with a Generous Interface. Presented at the 5th Workshop on Visualization for the Digital Humanities*, 2020, https://doi.org/10.48550/arXiv.2009.02242 [access: 7.11.2024].

Arnold T., Leonard P., Tilton L., *Knowledge Creation Through Recommender Systems,* "Digital Scholarship in the Humanities" 2017, vol. 32, pp. 151–157, https://doi.org/10.1093/llc/fqx035 [access: 7.11.2024].

Arnold T., Tilton L., *Distant Viewing: Computational Exploration of Digital Images*, Cambridge 2023.

Aske K., Giardinetti M., *(Mis)matching Metadata: Improving Accessibility in Digital Visual Archives through the EyCon Project*, "Journal on Computing and Cultural Heritage" 2023, vol. 16, issue 4, article 76, pp. 1–20, https://doi.org/10.1145/3594726 [access: 7.11.2024].

Bakker R., Rowan K., Hu L., Guan B., Liu P., Li Z., He R., Monge C., *AI for archives: Using facial recognition to enhance metadata*, "Works of the FIU Libraries" 2020, vol. 93, pp. 1–15, https://digitalcommons.fiu.edu/glworks/93 [access: 7.11.2024].

Bushey J., *Born digital images as reliable and authentic records*, master's thesis: University of British Columbia, 2005, https://doi.org/10.14288/1.0092057 [access: 7.11.2024].

Bushey J., *He Shoots, He Stores: New Photographic Practice in the Digital Age*, "Archivaria" 2008, vol. 65, issue 1, pp. 125–149, https://archivaria.ca/index.php/archivaria/article/view/13172 [access: 7.11.2024].

Bushey J., *The archival trustworthiness of digital photographs in social media platforms*, doctoral thesis: University of British Columbia, 2016, https://doi.org/10.14288/1.0300440 [access: 7.11.2024].

Chumachenko K., Mannisto A., Iosifidis A., Raitoharju J., *Machine learning based analysis of Finnish world war II photographers*, "IEEE Access" 2020, vol. 8, pp. 144184-144196, https://doi.org/10.1109/ACCESS.2020.3014458 [access: 7.11.2024].

Colavizza G., Blanke T., Jeurgens C., Noordegraaf J., *Archives and AI: An overview of current debates and future perspectives,* "Journal on Computing and Cultural Heritage" 2021, vol. 15, no. 1, article 4, pp. 1–15, https://doi.org/10.1145/3479010 [access: 7.11.2024].

Conway P., Punzalan R.L., *Fields of Vision: Toward a New Theory of Visual Literacy for Digitized Archival Photographs*, "Archivaria" 2011, vol. 71, pp. 63–97, https://archivaria.ca/index.php/archivaria/article/view/13331 [access: 7.11.2024].

Cox J., Tilton L., *The digital Public Humanities: Giving New Arguments and New Ways to Argue*, „Review of Communication" 2019, vol. 19, issue 2, pp. 127–146, https://doi.org/10.1080/15358593.2019.1598569 [access: 7.11.2024].

Delaney J., *An Inconvenient Truth? Scientific Photography and Archival Ambivalence*, "Archivaria" 2008, vol. 65, pp. 75–95, https://archivaria.ca/index.php/archivaria/article/view/13169 [access: 7.11.2024].

Dentler J., *Workshop Report: Multimodal Visual Similarity Algorithms and Digitized Photo Archives. EyCon Visual AI and Early Conflict Photography*, Blog Post, 2023, https://eycon.hypotheses.org/1539 [access: 7.11.2024].

Eiler F., Graf S., Dorner W., *Artificial intelligence and the automatic classification of historical photographs* [in:] *Proceedings of the Sixth International Conference on Technological Ecosystems for Enhancing Multiculturality*, ed. F.J. García-Peñalvo, New York 2018, pp. 852–856, https://doi.org/10.1145/3284179.3284324 [access: 7.11.2024].

Fewster K., *Case Study: Testing computational Archival Science frameworks using AI tools in analyzing the Spelman College Archives photograph collection,* InterPARES Trust AI, 2024, https://interparestrustai.org/assets/public/dissemination/ProctorCaseStudy.pdf [access: 7.11.2024].

Fewster K., *Case Study: The Endangered Archives Programme's use of AI tools in evaluating Jacques Toussele's Cameroonian photography archives,* InterPARES Trust AI, 2024, https://interparestrustai.org/assets/public/dissemination/ZeitlynInterviewCaseStudy.pdf [access: 7.11.2024].

Han X.Y., Papyan V., Prokop E., Donoho D.L., Johnson C.R., *Chapter 1: Artificial intelligence and discovering the digitized photoarchive* [in:] *Digital Humanities Research*, ed. L. Jailant, Bielefeld 2022, pp. 29–60, https://doi.org/10.14361/9783839455845-002 [access: 7.11.2024].

Leary W.H., *The archival appraisal of photographs: a RAMP study with guidelines*, Paris 1985, https://unesdoc.unesco.org/ark:/48223/pf0000063749 [access: 7.11.2024].

Lincoln M., Corrin J., Davis E., Weingart S.B., *CAMPI: computer-aided metadata generation for photo archives initiative*, Pittsburgh 2020, https://doi.org/10.1184/R1/12791807.v2 [access: 7.11.2024].

Long D., Magerko B., *What is AI literacy? Competencies and design considerations* [in:] *CHI'20 : proceedings of the 2020 CHI Conference on Human Factors in Computing Systems: April 25–30, 2020, Honolulu, HI, USA*, New York 2020, pp. 1–16.

Mallick S., *EyCon: What are we doing with Machine Learning and Computer Vision*, EYCON Blog Post, 2022, https://eycon.hypotheses.org/1020 [access: 7.11.2024].

Mannheimer S., Rossmann D., Clark J., Shorish Y., Bond N., Scates Kettler H., Sheehey B., Young S.W.H., *Introduction to the Special Issue: Responsible AI in Libraries and Archives*, "Journal of eScience Librarianship" 2024, vol. 13, no. 1, https://publishing.escholarship.umassmed.edu/jeslib/article/id/860/ [access: 7.11.2024].

Milleville K., Broeck A.V.D., Vanderperren N., Vissers,R., Priem M., Van De Weghe N., Verstockt S., *Enriching image archives via facial recognition,* "Journal on Computing and Cultural Heritage" 2023, vol. 16, no. 4, pp. 1–18, https://doi.org/10.1145/3606704 [access: 7.11.2024].

O'Donnell L., *Towards Total Archives: The Form and Meaning of Photographic Records*, "Archivaria" 1994, vol. 38, pp. 105–118, https://archivaria.ca/index.php/archivaria/article/view/12028 [access: 7.11.2024].

Oestreicher C., *Reference and Access for Archives and Manuscripts,* Chicago 2020.

Proctor J., Marciano R., *An AI-assisted framework for rapid conversion of descriptive photo metadata into linked data* [in:] *IEEE International Conference on Big Data (Big Data)*, 2021, pp. 2255–2261, https://doi.org/10.1109/BigData52589.2021.9671715 [access: 7.11.2024].

Ritzenthaler M.L., Vogt-O'Connor D., *Photographs: archival care and management*, Chicago 2006, https://search.worldcat.org/title/Photographs-:-archival-care-and-management/oclc/70175019 [access: 7.11.2024].

Rockembach M., *AI Literacy: A Muse for Records Management and Archival Professionals* [in:] *Artificial Intelligence and Documentary Heritage. SCEaR Newsletter 2024, Special Issue 2024*, eds. L. Duranti, C. Rogers, 2024, pp. 90–95, https://interparestrustai.org/assets/public/dissemination/SCEaRNewsletter SpecialIssue2024ArtificialIntelligence.pdf [access: 7.11.2024].

Schwartz J.M., *Coming to Terms with Photographs: Descriptive Standards, Linguistic "Othering" and the Margins of Archivy*, "Archivaria" 2002, vol. 54, pp. 142–171, https://archivaria.ca/index.php/archivaria/article/view/12861 [access: 7.11.2024].

Schwartz J.M., *Records of Simple Truth and Precision: Photography, Archives, and the Illusion of Control*, "Archivaria" 2000, vol. 50, pp. 1–40, https://archivaria.ca/index.php/archivaria/article/view/12763 [access: 7.11.2024].

Schwartz J.M., "*We Make Our Tools and Our Tools Make Us": Lessons from Photographs for the Practice, Politics, and Poetics of Diplomatics*, "Archivaria" 1995, vol. 40, pp. 40–74, https://archivaria.ca/index.php/archivaria/article/view/12096 [access: 7.11.2024].

Wevers M., Smits T., *The visual digital turn: Using neural networks to study historical images*, "Digital Scholarship in the Humanities" 2020, vol. 35, issue 1, pp. 194–207, https://doi.org/10.1093/llc/fqy085 [access: 7.11.2024].

Netography

AEOLIAN Network. Homepage, https://www.aeolian-network.net/ [access: 7.11.2024].

AURA Network. Homepage, https://www.aura-network.net/ [access: 7.11.2024].

Github. katerynaCh / Finnish-WW2-photographers-analysis, https://github.com/katerynaCh/Finnish-WW2-photographers-analysis [access: 7.11.2024].

InterPARES Trust AI. Home Page, https://interparestrustai.org/ [access: 7.11.2024].

LUSTRE. Home Page, https://lustre-network.net/team/ [access: 7.11.2024].

The EyCon project (eng.). (n.d.), https://eycon.hypotheses.org/ [access: 7.11.2024].